PIPS 3.0

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LONG-TERM GOALS

To develop, test, demonstrate and evaluate nowcast/forecast systems for polar sea ice. These systems are developed and tested in this 6.2 program and then transitioned into a 6.4 program for final evaluation and testing under near real time operational conditions. This project is specifically designed to address improvements to the sea ice model presently used by the U.S. Navy as part of its Polar Ice Prediction System 2.0 (PIPS 2.0)

OBJECTIVES

The objective of this project is to upgrade the existing PIPS 2.0 sea ice forecasting system by including in the model advances in our knowledge of sea ice dynamics and thermodynamics that have taken place over the past decade. In addition, improvements to the interaction of sea ice with both the atmospheric forcing (one way coupling) and ocean forcing (two-way coupling to the ocean model) are a key part of the PIPS 3.0. Data assimilation is also a key part of this system and as such new strategies for data assimilation will be incorporated into the PIPS 3.0 system. Once the appropriate model is developed and tested, it will be transitioned into the U.S. Navy's 6.4 programs for advanced developmental testing before transition into operations, the ultimate goal of the project.

APPROACH

The approach being taken to upgrade the PIPS 2.0 to a PIPS 3.0 system is through the interaction of a team of scientists that spans from the academic community directly to the operational user of the product. The academic community is working with the numerical modeling group at the Naval Post Graduate School (NPS) to incorporate changes to the existing code. NPS scientists test these changes for valid improvement to the PIPS 2.0 system. The final improved system is then forwarded to the Naval Research Laboratory for 6.4 near operational testing before operational delivery. Throughout this procedure, the ultimate user of the product, the National Ice Center (NIC), is kept advised of progress. As the user, the NIC is also asked for input concerning the resultant products and how they may be used. Key individuals working on this project are: Pamela Posey who obtains and provides atmospheric forcing, and who runs the test versions of the PIPS 2.0/PIPS 3.0 systems.

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14. ABSTRACT
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WORK COMPLETED

During this year we have interacted with other team members at two PIPS 3.0 working group meetings, one held at the NIC, location of the product user and the other at the Fleet Numerical Meteorology and Oceanography Center, location of the operational center that runs the forecast model.

We worked with Tony Beesley, NIC Postdoc, in his evaluation of NOGAPS temperature, cloud cover and wind field for the period 1997-1998 corresponding to the SHEBA observations. Dr. Beesley documented the results of this evaluation in an NIC report.

During this year we have provided NOGAPS atmospheric forcing data to scientists at the University of Washington (Schweiger) to commence a project that will evaluate the NOGAPS heat fluxes against observations in the Arctic building on the work of Beesley .

We have worked with Dr William Hibler of the University of Alaska Fairbanks to adapt and test a formulation (Hibler, JGR-Oceans, 2000) for a new "revised teardrop" shaped or "coulombic" yield curve to define the ice rheology used by the PIPS ice model. The adaptation of this code was transitioned to the Naval Post Graduate School (NPS) scientists for testing.

We have been working with the NPS to run test simulations of a 9 km resolution coupled ice ocean model. Although this model is not the final PIPS 3.0 model, this testing was performed to familiarize NRL with this type of code.

RESULTS

The result of the NIC analysis of the NOGAPS products agreed with what we have seen over the past few years in our examination of NOGAPS heat fluxes. The NOGAPS air temperatures were shown to be 9 degrees too warm on average in the SHEBA area in winter, while summer temperatures were in good agreement with the observations. Cloud cover was shown to be too intense in winter and only slightly greater tha observed in summer. Wind speeds were shown to become too large as the forecast time increases. Along with scientists at the University of Washington (Axel Schweiger), we continued this study and found that the warm bias in air temperatures has reversed to a cold bias in the past two years. These results were passed on the NRLMRY scientists, the developers of the NOGAPS model who are now investigating the reason for these biases. This is a key issue for operations. An improved PIPS 2.0 (PIPS 3.0) will not perform well if the fields driving it contain such biases.

In conjunction with William Hibler, the modified Hibler rheology was implemented in the PIPS 2.0 ice model. The modified code was run for a nine-year simulation using NOGAPS forcing. Figure 1 shows the ice concentration for June of 2000, the ninth year of the simulation, compared to the ice concentration of the standard PIPS 2.0 model. Although this figure shows the development of some lower concentration areas in the Greenland Sea, perhaps representative of the ability to generate lead-like features, the PIPS 2.0 horizontal resolution is only 28 km, generally too coarse for the resolution of leads. This code was transitioned to the NPS scientists to test with the higher resolution (9 km) model to determine if more lead-like structure appears with higher resolution.

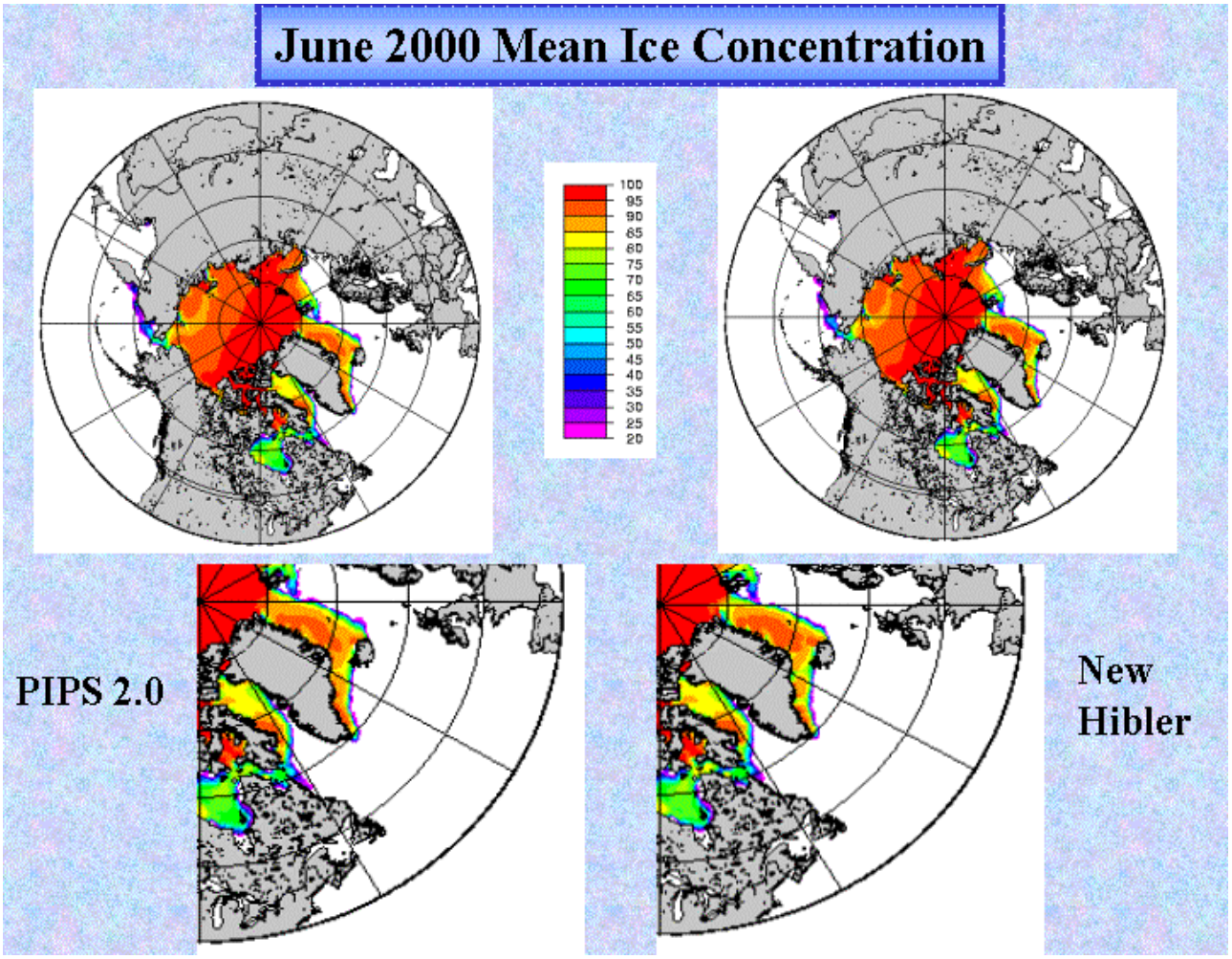

Figure 1. Ice concentration from June, 2000 for the entire PIPS domain and a zoomed view of the Greenland Sea from a run using the original PIPS 2.0 ice rheology and a run using the new modified Hibler rheology. The new rheology produces regions of smaller ice concentrations in the Greenland Sea and Fram Strait.

Working with the scientists at NPS, a 9 km horizontal resolution ice-ocean model was set up and several test runs and restart runs were made on a Cray T3E at the NAVOCEANO MSRC. This code consisted of a shared memory (SHMEM) version of the PIPS 2.0 ice model coupled to the NPS version of the POP ocean model. This code was representative of the type and size (memory, disk-space and and time) of model that will be the PIPS 3.0 system. The PIPS 3.0 model will include the assimilation of ice drift vectors from both SSM/I derived ice drift and buoy data. The new model will also include a new multilevel ice thickness and improved thermodynamics (Bitz and Lipscomb, 1999) and possibly the new Hibler rheology. These codes should commence transition to NRL for 6.4 advanced evelopmental testing early in FY02.

IMPACT/APPLICATIONS

This project should provide a valuable demonstration of how improvements to forecast systems or even the development of forecast systems can be accomplished by creating a team of scientists covering the entire pathway from 6.1-6.2-6.4-operations-users. The ultimate goal is to provide an improved ice model that will result in upgraded products for the end user.

TRANSITIONS

Transitions from this project will go directly into the 6.4 SPAWARS PIPS 2.0 Scalable Upgrade project with the ultimate goal being an upgrade to the PIPS 2.0 operational system.

RELATED PROJECTS

Several ONR Arctic program funded projects, such as the development of new ice rheologies and the evaluation of ice and ocean models used in these forecasts systems.

NIC Post Doctoral Program

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PUBLICATIONS

Preller, R.H., W. Maslowski, D. Stark. P.G. Posey, T.C. Pham, 2002: Navy Sea Ice Prediction Systems, Oceanography, The Oceanography Society, in press.

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PATENTS